MODEL 3800

Wide Range
Strain Indicator

3800
Instruction Manual

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INSTRUCTION MANUAL

MODEL 3800 *WIDE RANGE* STRAIN INDICATOR

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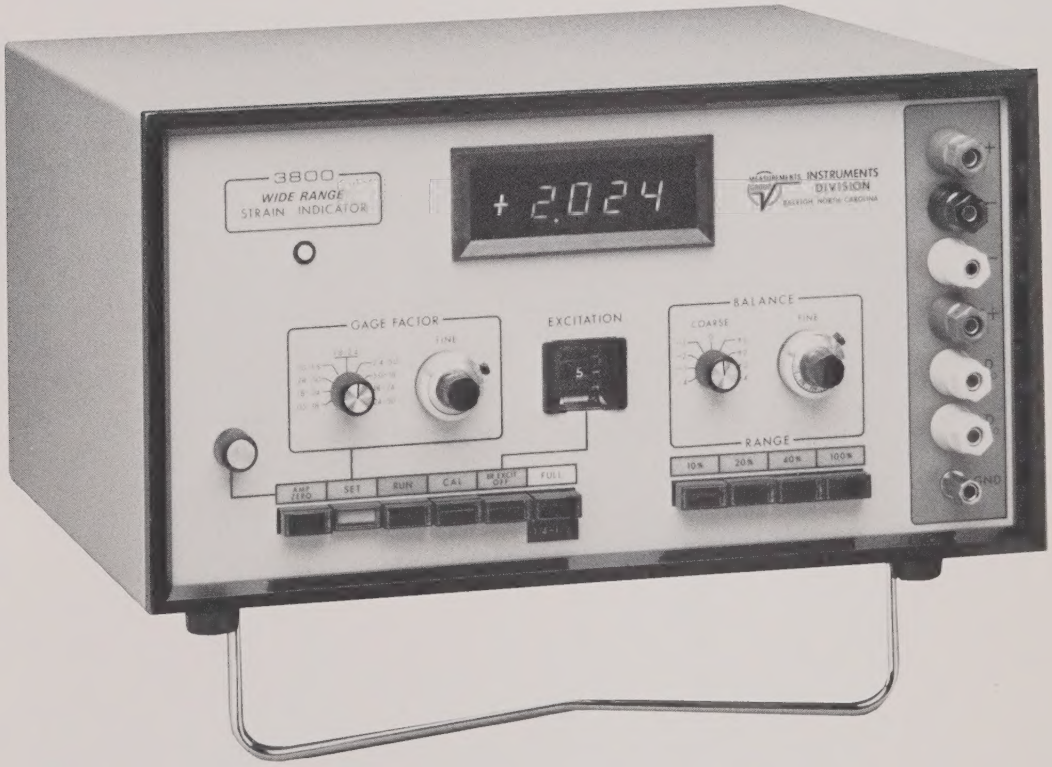


Model 3800 *Wide Range* Strain Indicator

1.0 GENERAL DESCRIPTION

The Model 3800 *Wide-Range* Strain Indicator is a highly versatile, precision instrument specifically designed for use with strain gages and strain-gage-based transducers. Its unique combination of "wide-range" features, precision circuitry and easy-to-use operating controls makes the Model 3800 the ideal choice for many strain gage and transducer measurement applications.

Gage factor is settable by front panel controls over a range of 0.0500 to 50.00. Gage factor is automatically displayed when the function push button is in the SET position.

The balance controls of the Model 3800 provide a total balance range of greater than ±100% of full-scale reading at a gage factor of 2.000. The balance range is further subdivided into 32 overlapping ranges to obtain precise settability and resolution. All balance voltages are electronically injected into the input amplifier. This method eliminates potentiometric bridge loading errors and does not compromise the measurement range of the instrument.

The excitation voltage of the Model 3800 is precisely settable by a front-panel thumbwheel switch over a range of 1 to 15 volts in one-volt increments. The amplifier gain is automatically adjusted in inverse ratio to the excitation setting so that gage factor is independent of excitation. Likewise, the balance voltage injection circuits precisely track the excitation setting so that balance is retained as excitation voltage is varied.

The excitation voltage control may, therefore, be considered as a form of "signal-to-noise" switch. The higher excitation voltages will give lower amplifier gain, higher input signals and, therefore, superior "signal-to-noise" ratios.

Ultra-stable internal half-bridge, 120-ohm and 350-ohm dummy gages are provided. Shunt calibration is achieved by connection of shunt calibration resistors across the dummy gages. Calibration resistors are accessible at the rear panel of the instrument. In addition, operation of the front-panel calibration push button provides contact closures to two remote calibration resistors which are also mounted on the rear panel. Connections to the remote resistors are accessible via the rear-panel transducer input connector.

Connections to the Model 3800 may be made via the front-panel binding posts or the rear-panel transducer connector. The rear-panel connector contains the connections for the remote calibration resistors as well as remote sense connections for use with transducers.

CAUTION

When it becomes necessary to clean the front panel of the Model 3800, do not use solvents.

2.0 SPECIFICATIONS

Range and Display: ±19 999 counts, direct-reading LED display.

Resolution: 1$\mu\varepsilon$ at any GF from 0.0500 to 50.00. 0.10 μV/V as a transducer indicator.

Linearity: ±0.01% of full scale.

Balance Range:

Coarse Balance: ±2.5% to ±100% of full scale per step, in 32 total steps.

Fine Balance: ±1.25% to ±50% of full scale; overlaps each coarse balance step.

Balance Method: Electronically injected counter-emf.

Gage Factor:

Range: 0.0500 to 50.00; displayed by LED readout when in the SET position.

Resolution: 0.0001 from GF of 0.0500 to 0.5000. 0.001 from GF of 0.500 to 5.000. 0.01 from GF of 5.00 to 50.00.

Linearity: ±0.05% of full scale.

Accuracy: ±1 least significant digit.

Excitation Voltage: 1.000 to 15.000 Vdc ±1 mV ±0.02%. Settable in 1V increments by front-panel thumbwheel switch.

Temperature Stability: ±0.01%/°C.

Amplifier:

Temperature Effect on Zero: ±1.0 μV/°C RTI (referred to input) max; ±0.50 μV/°C RTI typical.

Temperature Effect on Span: ±0.005%/°C max.

Warm-up Drift: Less than ±3 μV RTI from turn-on to 5 minutes.

Random Drift at Constant Ambient Temperature: Less than ±1 μV RTI.

Common-Mode Rejection: Greater than 100 dB at 50-60 Hz.

Common-Mode Voltage: ±8V max.

Input Impedance: Greater than 100MΩ differential and common mode.

Input Circuits: 60Ω to 10 000Ω half or full bridge. Internal dummy gages are provided for 120Ω and 350Ω quarter bridges.

Calibration: Shunt calibration resistors are provided across internal 120Ω and 350Ω dummy gages to simulate 5000$\mu\varepsilon$ ±0.05%. Calibration resistors are located on the rear panel and may be changed to suit specific requirements.

Contact closures are provided for two rear-panel-mounted resistors to facilitate any calibration configuration. Typical use is double-shunt calibration of transducers.

Analog Ouput:

Linear Output: ±10.00V max; adjustable over 11:1 range by a ten-turn potentiometer mounted on the rear panel.

Output Load: 2000Ω min resistance.

Bandwidth: DC to 5 kHz (−3 dB nominal).

Output Noise: Less than 2.5 μV p-p 0.10 to 10 Hz, RTI. Less than 2 μV rms dc to 5 kHz, RTI plus 0.005% of full scale RTO (referred to output).

Remote Sense: Remote sense connections are provided at transducer connector.

Remote sense error less than 0.0005%/Ω of lead resistance; maximum lead resistance less than 40Ω.

Power: 115/230 Vac, 50-60 Hz, less than 10 volt-amperes.

Size: 12.5 x 11 x 6.5 in *(318 x 280 x 165 mm).*

Weight: 10.2 lb *(4.6 kg).*

The **Analog Output** Bandwidth specification has been changed to the following:

Bandwidth at GF greater than 0.500:
DC to 4.5 kHz (−3 dB nominal).

Bandwidth at GF less than 0.500:
DC to 2.0 kHz (−3 dB nominal).

3.0 DESCRIPTION OF CONTROLS

3.1 GENERAL

The Model 3800 is specifically designed so that the operation of the front-panel controls and push-button switches is straightforward and largely self-explanatory. The push buttons are color-coded and the operating mode can be immediately recognized. Where appropriate, certain push buttons are interlocked so that no improper operating mode can be selected.

3.2 POWER ON AND EXCITATION

Power is applied to the Model 3800 by the toggle switch mounted on the rear panel of the instrument. The front-panel LED indicates when power is ON.

Excitation voltage to the bridge circuit is adjusted by the front-panel EXCITATION thumbwheel switch. Excitation is precisely settable over a 1- to 15-volt range in one-volt increments. The electronically injected balance voltage automatically tracks the excitation setting so that balance is retained when excitation is varied. Excitation voltage is electronically removed from the bridge circuit when the BR EXCIT OFF push button is depressed.

3.3 AMP ZERO – Orange

When the AMP ZERO push button is depressed, the amplifier inputs (S+, S–) are disconnected from the input terminals and are connected internally to analog ground. (See Schematic Diagram on Page 15).

The BALANCE controls (COARSE and FINE) are also disabled. In this position, the AMP ZERO control is adjusted for a display of ±0000. (Note: It is desirable that AMP ZERO be adjusted at the gage factor setting and the excitation setting that will be used during the particular test sequence.)

> If EXCITATION or GAGE FACTOR will be varied during a test sequence, always set the AMP ZERO at the ***lowest*** excitation and ***lowest*** gage factor.

3.4 GAGE FACTOR – Orange

When the SET push button is depressed, the instrument is configured so that the gage factor is displayed by the LED display. The desired gage factor range is selected using the rotary GAGE FACTOR switch. the exact gage factor is then set with the adjacent ten-turn potentiometer, and locked using the potentiometer locking mechanism.

3.5 RUN – Green

When the RUN push button is depressed, the instrument is configured to measure strain (or transducer output) as presented to the input terminals or transducer connector.

3.6 CAL – Orange

When the CAL push button is depressed, the calibration resistors are connected across the internal 120Ω and 350Ω dummy gages. In addition, the remote calibration resistors are connected to the appropriate pins of the transducer connector. All other circuits are the same as in the RUN mode.

3.7 BR EXCIT OFF – Orange

When the BR EXCIT OFF push button is depressed, excitation voltage is electronically removed from P+, P– terminals and from the transducer connector, and the BALANCE controls (COARSE and FINE) are disabled. This position is most often used to check for extraneously induced noise or thermal voltages in measuring systems which employ complex input configurations, or input configurations which may be subject to wide temperature fluctuations.

3.8 FULL/ 1/2-1/4 – Yellow

When this push button is depressed, the internal half bridge is disconnected from the S+ terminal, and the instrument is configured for full-bridge operation. This button is not interlocked, and is selectable at the option of the user.

3.9 AMP ZERO CONTROL

The AMP ZERO control is a ten-turn potentiometer used to set the electrical zero of the amplifier when the AMP ZERO push button is depressed. The setting must not be changed during a measurement sequence or when in any other operating mode. See Section 3.3 for additional details.

3.10 GAGE FACTOR SWITCH

The gage factor range is selected by setting the GAGE FACTOR switch to the desired position. Gage factor is displayed by the LED readout when the SET push button is depressed. Also, see Section 3.3.

3.11 GAGE FACTOR CONTROL

The exact value of gage factor is set by using the ten-turn GAGE FACTOR potentiometer. A locking mechanism provides a means to lock the potentiometer at the desired setting.

3.12 BALANCE RANGE PUSH BUTTON

The overall BALANCE RANGE of the Model 3800 is set by the selection of a BALANCE RANGE push button. The push button ranges are labeled 10%, 20%, 40%, and 100%. These percentages refer to percent of full-scale reading at a gage factor setting of 2.000. The balance range at gage factor settings other than 2.000 is inversely proportional to the particular gage factor setting (normalized to a gage factor setting of 2.000).

Each push button range is further subdivided into eight ranges (four positive and four negative) by the COARSE BALANCE switch.

The FINE BALANCE control is a ten-turn potentiometer which overlaps each position of the COARSE BALANCE switch. A calibrated locking mechanism is provided on the FINE BALANCE potentiometer. In addition, at a FINE BALANCE setting of 5.00, a COARSE BALANCE swtich setting of ±0, and a BALANCE RANGE push-button setting of 10%, the injected balance voltage is internally set to essentially zero. These settings are used to check for thermal offsets or other extraneously injected voltages.

3.13 ANALOG OUTPUT

The ANALOG OUTPUT is available from the rear-panel BNC connector. Since the Model 3800 is specifically designed as a ***strain indicator, there will not be a corresponding increase in analog output*** when excitation voltage is increased. The analog output voltage will track the digital display but is separately adjustable over an 11:1 range by the ANALOG OUTPUT level control.

3.14 ANALOG OUTPUT LEVEL CONTROL

The ANALOG OUTPUT level is adjustable over an 11:1 range by the ANALOG OUTPUT level control. This control is a ten-turn potentiometer located adjacent to the analog output connector on the rear panel. A calibrated locking mechanism is provided to facilitate undisturbed operation and resetting to specific output levels.

3.15 CALIBRATION RESISTORS

Calibration resistors for shunt calibration across the 120Ω and 350Ω dummy gages are mounted on the rear panel. The calibration resistors are separately packaged and must be installed by the user. Alternate values of calibration resistors may be used if desired. It is mandatory, however, that all calibration resistors be ultra-stable, metal-film types. The values which are supplied with the instrument are 11 940Ω (120Ω bridge) and 34 825Ω (350Ω bridge).

3.16 REMOTE CALIBRATION

Push posts for remote calibration resistors are provided on the rear panel. When the CAL push button is depressed, these push posts are connected through the CAL push button switch to the appropriate pins of the rear-panel TRANSDUCER connector. The resistors may be used to implement any desired method of calibration. Care should be exercised that the relative merits and limitations of each calibration arrangement are thoroughly understood.

3.17 TRANSDUCER CONNECTOR

Transducers are normally connected to the Model 3800 via the rear panel TRANSDUCER connector. Bridge excitation, signal inputs, remote sense and remote shunt calibration contacts are provided in this connector.

3.18 POWER AND FUSE

POWER is applied to the instrument via the power connector mounted on the rear panel. The switch mounted adjacent to the power connector selects either 115 Vac or 230 Vac operation. The FUSE for the Model 3800 is also mounted at the same location.

4.0 OPERATING PROCEDURES – STRAIN GAGE INPUTS

4.1 PRELIMINARY SET-UP

(a) Set the POWER switch ON.

(b) Depress the AMP ZERO push button.

(c) Adjust the AMP ZERO potentiometer for a display reading of ±0000.

(d) Allow the unit to stabilize for a minimum of five minutes and repeat adjustment.

4.2 INPUT CONNECTIONS

Resistive strain gages are normally connected at the binding posts on the front panel. These binding posts are color-coded in accordance with conventional practice and are clearly labeled. Figure 1 shows input connections for full-, half-, and quarter-bridge configurations.

Connect the strain gage(s) to the instrument at the appropriate binding posts.

4.3 FULL/ 1/2-1/4

Select the desired bridge configuration using the FULL/ 1/2-1/4 push button.

4.4 EXCITATION

Set the EXCITATION thumbwheel switch to the desired excitation voltage.

4.5 GAGE FACTOR

Depress the SET push button. Set the GAGE FACTOR switch to the required range. Adjust the ten-turn GAGE FACTOR potentiometer for the exact gage factor. (Gage factor is displayed by the LED readout when the SET push button is depressed).

The required gage factor will normally be the gage factor given by the manufacturer on the engineering data sheet supplied with the strain gages. See also Section 4.9.

4.6 AMP ZERO

It is desirable that AMP ZERO be adjusted at the gage factor setting and the excitation voltage that will be used during a particular test sequence.

> If EXCITATION or GAGE FACTOR will be varied during a test sequence, always adjust AMP ZERO at the ***lowest*** excitation voltage and the ***lowest*** gage factor.

Depress the AMP ZERO push button. Adjust the AMP ZERO potentiometer for a display of ±0000.

4.7 RUN

Depress the RUN push button. In this mode the instrument is configured to read the strain as presented to the S+, S− terminals.

4.8 BALANCE

Depress the 10% push button. Set the COARSE BALANCE switch to ±0. Adjust FINE BALANCE potentiometer for a display of ±0000.

If balance cannot be achieved, rotate the COARSE BALANCE switch to reduce reading to near zero. Complete balance with the FINE BALANCE potentiometer.

If balance still cannot be achieved, depress the next higher BALANCE RANGE push button and repeat above steps.

> If the GAGE FACTOR or EXCITATION will be changed during a particular test sequence, initial BALANCE adjustments should be made at the ***lowest*** gage factor and the ***lowest*** excitation voltage.

4.9 CALIBRATION

The Model 3800 utilizes shunt calibration resistors across the internal 120Ω and 350Ω dummy gages for quarter-bridge calibration. The calibration resistors simulate 5000$\mu\epsilon$ at a gage factor of 2.000. At gage factors other than 2.000, the displayed reading will be:

$$5000\mu\epsilon \times \frac{2.000}{GF} \pm 0.05\% \text{ (assuming negligible lead resistance).}$$

When using the quarter-bridge configuration, the CAL position can be used in conjunction with the GAGE FACTOR potentiometer to compensate for leadwire resistance. This procedure is as follows:

(a) Depress CAL push button.

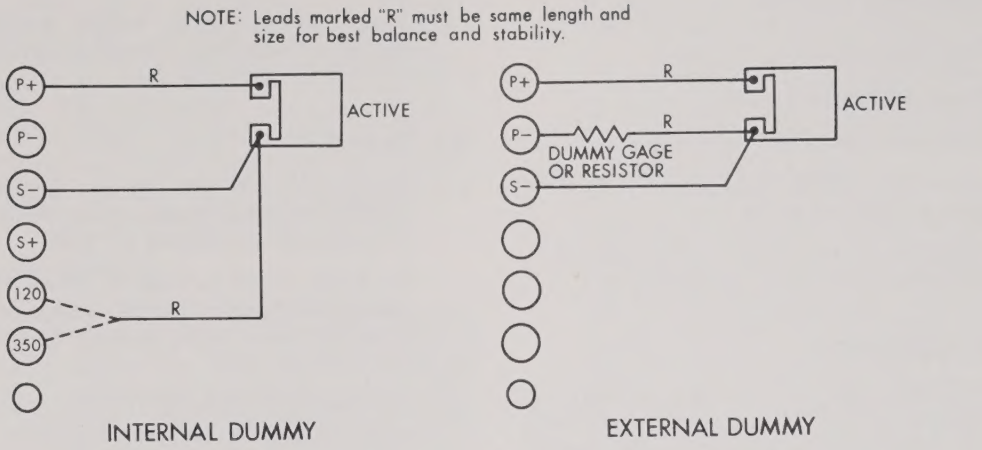
(b) Calculate $\frac{2.000}{GF} \times 5000\mu\epsilon$ = calibration number.

(c) Adjust the GAGE FACTOR potentiometer to give a reading equal to the calibration number.

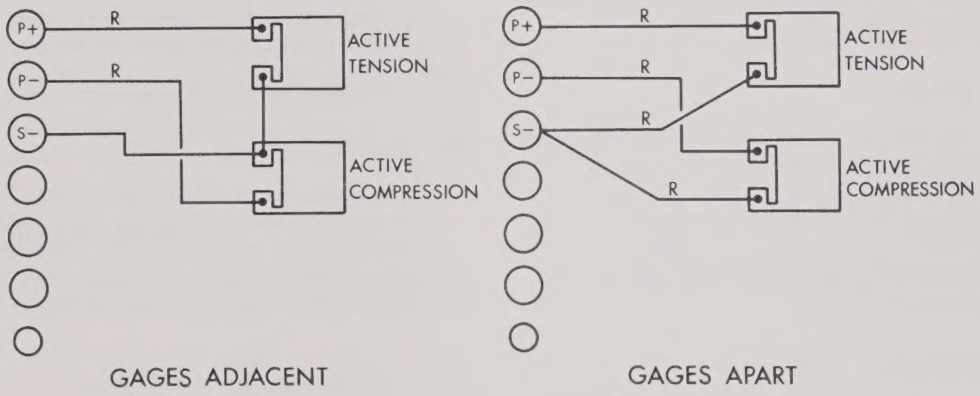
(d) Lock the GAGE FACTOR potentiometer in place.

NOTE: If the SET push button is subsequently depressed, the gage factor which is displayed by the LED readout may not be the same as the gage factor in Step 4.5 above. This is due to the fact that the instrument is making the desired correction for leadwire resistance.

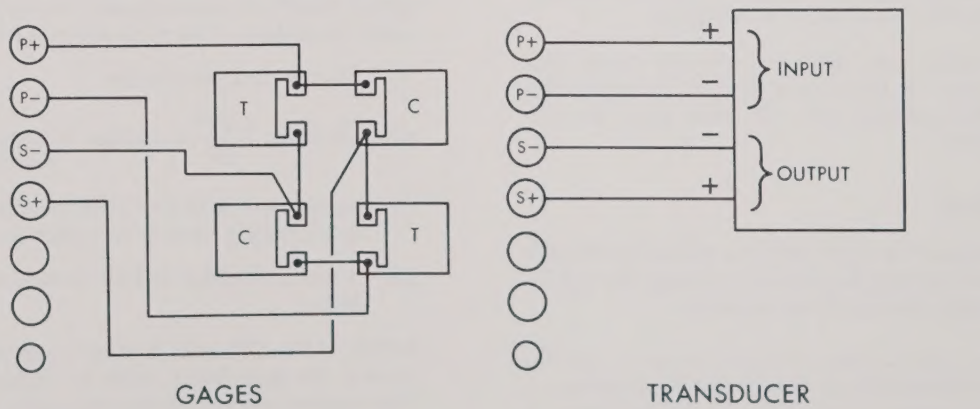
Alternately, if the leadwire resistance is known, the required gage factor to compensate for leadwire desensitization can be calculated.



QUARTER BRIDGE



HALF BRIDGE



FULL BRIDGE

Figure 1: Input connections

Example:

- 350Ω active gage connected in a three-wire quarter-bridge configuration.
- Leadwire resistance is known to be 3Ω in each lead. [See Figure 1 for the resistance (R) value to be used in a particular calculation.]
- Stated gage factor = 2.080
- Corrected gage factor =

$$\frac{350}{350+3} \times 2.080 = 2.062.$$

- Gage factor should be set to 2.062.
- Calibration number will be

$$\frac{2}{2.062} \times 5000\mu\epsilon = 4850 \pm 0.05\%$$

4.10 HIGH-PRECISION STRAIN MEASUREMENTS

The Model 3800 can be used to obtain extremely accurate, high-resolution strain measurements in a variety of circumstances. Resolutions of 0.10$\mu\epsilon$ are routinely possible if the excitation voltage can be kept above 5.0V. Even higher resolution is possible if excitation voltage can be kept in the 10 to 15V range and the operating environment is relatively noise-free. The example below illustrates the use of the Model 3800 for such applications.

Problem:

In a microcreep study, the full-range of strain is expected to be less than 100$\mu\epsilon$. It is desirable that resolution of 0.10$\mu\epsilon$ be obtained. A quarter-bridge configuration is to be used, and the test specimen and gage pattern are such that an excitation voltage of 10V presents no self-heating problem.

A precision shunt calibration resistor representing 1000$\mu\epsilon$ will be used across the internal dummy gage to calibrate the system. The manufacturer's specified gage factor for the measuring gage is 2.080.

Procedure:

Connect the gage to the Model 3800 using the three-leadwire configuration shown in Figure 1 for quarter-bridge connections. Connect the precision calibration resistor to the appropriate (120Ω or 350Ω) rear-panel terminals.

Set EXCITATION to 10V.

Set the GAGE FACTOR range switch to the .18–.24 range. Depress the SET push button and adjust the GAGE FACTOR potentiometer for a reading of 0.2080 (0.1 x 2.080).

Depress the AMP ZERO push button and adjust the AMP ZERO potentiometer for a reading of ±0000.

Depress the RUN push button. Use the BALANCE range push buttons, the COARSE BALANCE switch, and the FINE BALANCE potentiometer to obtain a reading of ±0000.

Depress the CAL push button. Readjust the GAGE FACTOR potentiometer for a reading of exactly 10 000. This reading represents 1000.0$\mu\epsilon$. The readjustment of gage factor will compensate for any leadwire resistance in the system. See Section 4.9.

Depress the RUN push button. The Model 3800 will now indicate any change in strain applied to the test specimen with a resolution of 0.10$\mu\epsilon$.

4.11 WIDE-RANGE STRAIN MEASUREMENTS

Problem:

In a study of the characteristics of a structural plastic, it is expected that strains on the order of 50 000$\mu\epsilon$ will be encountered. Moreover, the gage patterns which can be accommodated by the test specimen are quite small, and excitation voltage must be kept low. It is decided that a quarter-bridge configuration will be used, and excitation voltage will be limited to 2.0V. A precision shunt calibration resistor representing 100 000$\mu\epsilon$ will be used across the internal dummy gage to calibrate the system. The manufacturer's specified gage factor for the measuring gage is 2.080.

Procedure:

Connect the gage to the Model 3800 using the three-leadwire configuration shown in Figure 1 for quarter-bridge connections.

Connect the precision calibration resistor to the appropriate (120Ω or 350Ω) rear-panel terminals.

Set EXCITATION to 2.0V.

Set the GAGE FACTOR range switch to the 18–24 range. Depress the SET push button and adjust the GAGE FACTOR potentiometer for a reading of 20.80 (10 x 2.080).

Depress the AMP ZERO push button and adjust the AMP ZERO potentiometer for a reading of ±0000.

Depress the RUN push button. Use the BALANCE range push buttons, the COARSE BALANCE switch and the FINE BALANCE potentiometer to obtain a reading of ±0000.

Depress the CAL push button. Readjust the GAGE FACTOR potentiometer for a reading of exactly 10 000. This reading represents a strain of 100 000$\mu\epsilon$ with a resolution of 10$\mu\epsilon$. The readjustment of gage factor will compensate for any leadwire resistance in the system. See Section 4.9.

Depress the RUN push button. The Model 3800 will now indicate any strain applied to test specimen. Resolution of the system is 10$\mu\epsilon$, and full-scale range is ±199 990$\mu\epsilon$.

5.0 OPERATING PROCEDURES – TRANSDUCERS

Transducers are normally connected to the Model 3800 through the rear-panel TRANSDUCER connector. Bridge excitation, signal inputs, remote sense and remote shunt calibration connections are provided in this connector. Typical wiring to the TRANSDUCER connector is shown in Figure 2.

5.1 INPUT CONNECTIONS

Set the POWER switch to ON.

Depress the AMP ZERO push button.

The Model 3800 is supplied with one input connector, Measurements Group Part Number 12X300531. Additional connectors may be ordered from the Measurements Group or from electronic parts distributors. Suggested and compatible types are:

Bendix	PT06A-14-15(SR)
ITT/Cannon	KPT06B14-15P
Burndy	BT06AC14-15P

Connect the transducer to the input connector as shown in Figure 2. Use of the remote sense capability is optional. The remote calibration resistors may be used to implement any calibration configuration recommended by the transducer manufacturer or as dictated by good engineering practice.

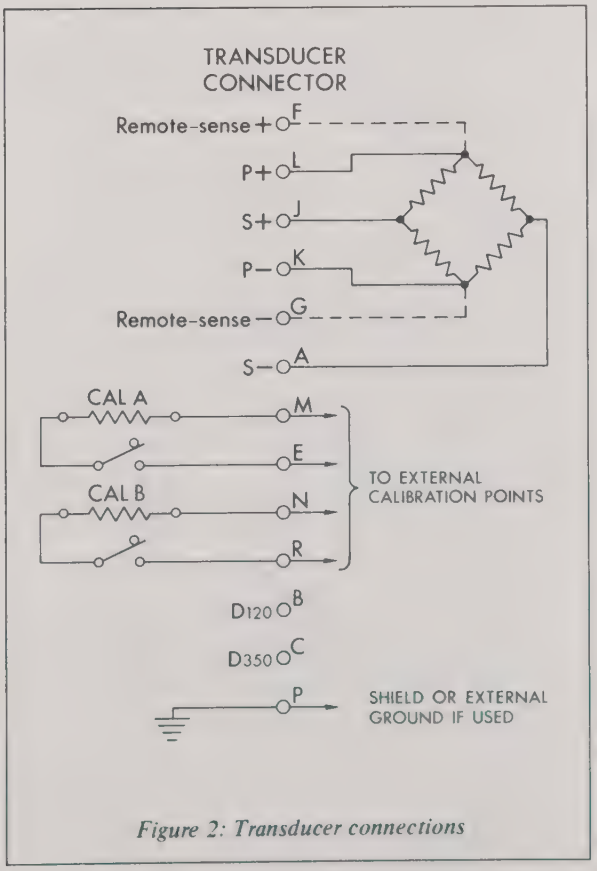


Figure 2: Transducer connections

5.2 GAGE FACTOR

The Model 3800 may be used to give a readout in engineering units or in mV/V. Also, since a wide range of excitation is available, excitation can be varied to determine the effect upon transducer performance.

The relationship between the gage factor (GF), the sensitivity (S) of the transducer in mV/V, and the Model 3800 readout in engineering units (EU) is:

$$GF = \frac{S \times 4000}{EU}$$

or,

$$EU = \frac{S \times 4000}{GF},$$

$$S = \frac{GF \times EU}{4000}.$$

Table 1 shows gage factor settings for several popular transducer sensitivities.

Since GF setting and EU (readout) are always known, the wide-range high-precision characteristics of the Model 3800 will enable very accurate studies of transducer behavior at the developmental or operational level.

Calculate the required gage factor according to the above equations. Set the GAGE FACTOR range switch to the calculated range. Depress the SET push button, and adjust the GAGE FACTOR potentiometer to the calculated value of gage factor. Lock the potentiometer in place.

TABLE 1
GAGE FACTOR vs TRANSDUCER SENSITIVITY

FULL SCALE COUNTS	G.F. SETTING		
	TRANSDUCER SENSITIVITY IN mV/V		
	1.5 mV/V	2.0 mV/V	3.0 mV/V
1000	6.000	8.000	12.000
1200	5.000	6.667	10.000
1500	4.000	5.333	8.000
2000	3.000	4.000	6.000
2500	2.400	3.200	4.800
3000	2.000	2.667	4.000
4000	1.500	2.000	3.000
5000	1.200	1.600	2.400
6000	1.000	1.333	2.000
7000	0.857	1.143	1.714
8000	0.750	1.000	1.500
9000	0.667	0.889	1.333
10 000	0.600	0.800	1.200
12 000	0.500	0.667	1 000
15 000	0 400	0.533	0.800
20 000	0.300	0.400	0.600

5.3 EXCITATION

Set the EXCITATION thumbwheel switch to the correct value of excitation voltage as recommended by the transducer manufacturer.

5.4 AMP ZERO

Depress the AMP ZERO push button. Adjust the AMP ZERO potentiometer for a reading of ±0000.

> If the GAGE FACTOR or EXCITATION will be varied during a test sequence, always adjust AMP ZERO at the ***lowest*** gage factor and ***lowest*** excitation voltage.

5.5 CALIBRATION

If the transducer is to be calibrated by use of external calibration resistor(s), depress the CAL push button. (It is assumed that the CAL resistors have been properly connected.) The readout should indicate the calibration value (usually full scale). If the readout is not precisely correct, adjust the GAGE FACTOR potentiometer to give the correct reading. Any major differences (>0.5%) between the calculated value for gage factor and the value determined by the calibration resistor(s) should be immediately suspect, and the reasons for the difference determined.

5.6 RUN

Depress the RUN push button.

Set the BALANCE RANGE push button to 10%.

Set the COARSE BALANCE switch to ±0.

Adjust the FINE BALANCE potentiometer to exactly 5.00.

The readout will now indicate any unbalance in the transducer and/or tare load on the transducer.

5.7 BALANCE

Depress the 10% push button. Set the COARSE BALANCE switch to ±0. Adjust FINE BALANCE potentiometer for a display of ±0000.

If balance cannot be achieved, rotate the COARSE BALANCE switch to reduce reading to near zero. Complete balance with the FINE BALANCE potentiometer.

If balance still cannot be achieved, depress the next higher BALANCE RANGE push button and repeat above steps.

The transducer may now be loaded and the readings taken.

5.8 BR EXCIT OFF

Depressing the BR EXCIT OFF push button removes excitation from the transducer. All other circuits remain the same as in the RUN position. The BR EXCIT OFF function is used to check for thermal offsets or other extraneously induced noise in the measuring circuit. If an oscilloscope or strip chart recorder is being used, it is often informative to observe the residual noise with BR EXCIT OFF.

The design of the circuitry associated with the BR EXCIT OFF function is such that this function can be used even when the remote sense leads are connected.

5.9 HIGH RESOLUTION TRANSDUCER MEASUREMENTS

The wide-range capabilities of the Model 3800 make possible extremely high resolution in either transducer development applications or in applications demanding precise measurements.

At a gage factor setting of 2.00, a transducer with a sensitivity of 2 mV/V will give a reading of 4000, or a resolution of 0.5 μV/V. The Model 3800 will, however, operate very satisfactorily at much lower gage factors (higher gain) if the excitation is 5.0V or above. For example, if gage factor for the above transducer is set to 0.4000, the reading will be nominally 20 000 for a resolution of 0.1 μV/V.

In cases where even greater resolution is required, this can be accomplished by using the wide-range balance capability in combination with the precise settability of gage factor. By using the balance controls to offset the unloaded reading of the transducer to a level below zero, a full-scale range of 39 998 counts can be obtained.

Example:

Transducer sensitivity is 2 mV/V.

Excitation is 10V.

Gage factor is set to 0.2000.

The balance controls are adjusted to give an unloaded reading of −19 999 counts.

Full-scale reading of +39 998 counts is now possible, with a resolution of 0.05 μV/V.

The above example is intended to illustrate the capabilities of the Model 3800 as a transducer indicator. Further applications are limited only by the ingenuity of the operator.

When precise, high-resolution measurements are to be made, the user ***must*** observe the following precautions:

(a) Excitation voltage should be as high as practical; in all cases, greater than 5.0V.

(b) AMP ZERO and BALANCE adjustments ***must*** be made at the ***lowest*** anticipated gage factor setting and at the ***lowest*** excitation voltage.

It is mandatory that the measurement procedure be well-defined prior to the test sequence in order that the full instrument capability can be effectively utilized.

5.10 HIGH-RESISTANCE STRAIN GAGE AND TRANSDUCER INPUTS

The low-bias currents and the wide-range balance capability of the Model 3800 will allow its use with high-resistance strain gages such as the M-M Fineline® series or with high-resistance strain-gage-based transducers. The only undesirable effect of the high resistance will be the generation of an input-referred offset voltage by the bias current of the input amplifier. The bias current of the Model 3800 amplifier is on the order of 4 nA maximum at +25°C.

This means, that if a 5000Ω full bridge were connected, the input-referred offset voltage would be 20 μV. Since the Model 3800 has a very wide balance range, this offset would be eliminated during the initial balance of the instrument; that is, it would not be an error-contributing factor.

The user will be aware of this offset only when the bridge excitation is turned off. In this case, the offset will cause a (usually small) reading which will not be due to thermal voltages or extraneously induced noise.

6.0 FUNCTIONAL DESCRIPTION

The following functional descriptions and block diagrams are intended to aid the user in fully utilizing the capabilities of the Model 3800. In all block diagrams, only typical components are shown for clarity of descriptions. Full circuit details are shown on the schematic diagram.

6.1 EXCITATION CONTROL

Figure 3 is a block diagram of the excitation control circuits of the Model 3800. U17 is a precision voltage reference, used for both the excitation circuits and as the reference voltage for the A/D converter. Therefore, the readings are essentially ratiometric, and slight variations in reference voltage will have no effect upon the accuracy of the instrument. The reference voltage is supplied to the D/A converters, U2 and U4 by U3. The output from the D/A converters is controlled by this reference voltage and by the BCD code which is obtained from switch S5. The output of the D/A converters is fed through U1 (and associated series transistors) to the P+, P– terminals. The feedback circuits from the P+, P– terminals to the D/A converters is completed via U3. If the RS+, RS– terminals are connected, feedback is derived directly from the sensing points and resistors R7 and R13 have no effect. For additional details, see schematic diagram.

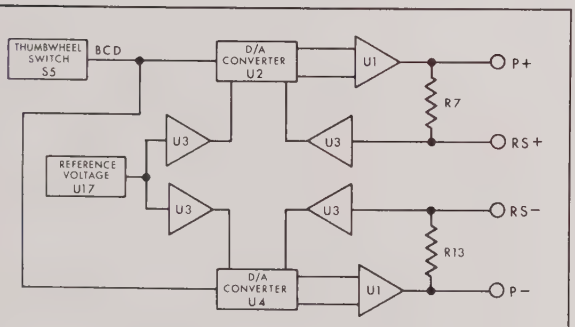


Figure 3: Excitation control

6.2 AMPLIFIER AND AMPLIFIER CONTROL

Figure 4 is a block diagram of the amplifier and amplifier control circuits. The signal voltage from the bridge circuit is fed to amplifier U7 via the S+, S– terminals. The gain of U7 is determined by the setting of the GAGE FACTOR range switch. Also the balance voltages are injected through this same circuit into U7. (See Section 6.3.) The output of U7 is fed to U8 which eliminates any common-mode signals and feeds the amplified signal to U9. U9 and U10 comprise a gain-controlled amplifier whose gain is in exact inverse proportion to the excitation setting. The excitation setting is fed to U9 in BCD code from the thumbwheel switch S5. The output of U10 is fed to the A/D converter.

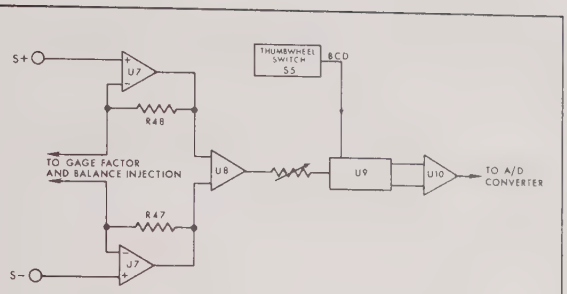


Figure 4: Amplifier and amplifier control

6.3 BALANCE CONTROL AND INJECTION

Figure 5 is a block diagram of the balance control and injection circuits. The excitation voltage is applied to the balance control circuitry via the remote sense amplifier U3. This method ensures that the injected balance voltage will always track the excitation voltage even if resistances are present in the P+, P– leads. The outputs from the FINE BALANCE control R83 and the COARSE BALANCE switch S6 are fed to the amplifier U5. The BALANCE RANGE push button controls the effective gain of U5. The output of U5 is applied to the balanced voltage followers U6. The output of U6 is essentially the injected balance voltage. This output is fed to the input amplifier through the GAGE FACTOR range switch S4. See schematic diagram for additional details.

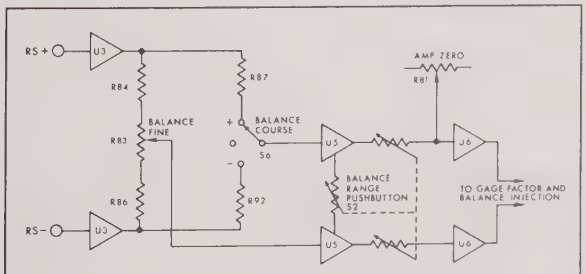


Figure 5: Balance controls and injection

6.4 GAGE FACTOR CONTROL

The GAGE FACTOR range switch and the GAGE FACTOR control perform two basic functions. First, the GAGE FACTOR control sets the reference voltage to the A/D converter to determine the full-scale sensitivity of the instrument. Second, the GAGE FACTOR range switch sets the overall gain of the input amplifier and selects the proper balance injection circuitry so that the injected balance voltage always tracks the amplifier gain.

Figure 6 is a block diagram of the GAGE FACTOR control circuits. A precise reference voltage is established by the voltage reference source U17. This voltage is supplied to the voltage divider R97, R98 and to the GAGE FACTOR range switch via the appropriate resistor networks. The resistor network for a particular gage factor range is selected by the GAGE FACTOR range switch and a voltage appears across the GAGE FACTOR control R114. When the FUNCTION push button is in the SET position, the A/D converter is configured so that the exact gage factor as set by the GAGE FACTOR control is displayed. This is accomplished by the follower amplifier U12, the voltage divider R97, R98, the voltage divider R67, R68 and the contacts of the FUNCTION push button. When the FUNCTION push button is returned to RUN position, the circuits are configured to the normal measuring mode.

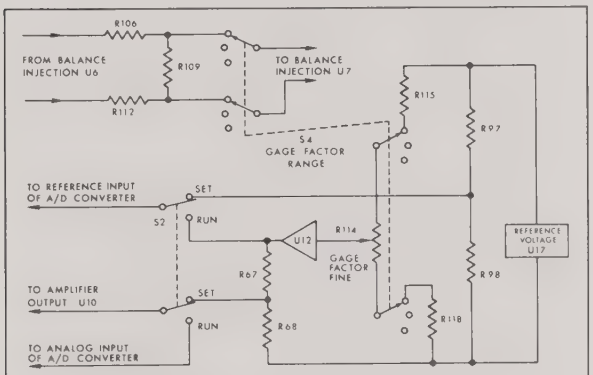


Figure 6: Gage factor control

6.5 A/D CONVERTER AND READOUT

Refer to Figure 7 in the following discussion. The amplified signal and the reference voltage from switch S2 are applied to the A/D converter. The signal is applied through the low-pass filter consisting of R61, R62, C6, C7 to the analog input terminal of U14. The reference voltage for the A/D converter is also applied to U14. The circuit composed of U11, CR1, CR2 is a clamp circuit to prevent severe overloading and slow recovery from overload in the A/D converter. The complete A/D converter is comprised of U14 (digital switch and counters), U13 (amplifier, integrator and comparator), and U15 (clock oscillator). Digital outputs from the A/D converter are fed to U18 and from U18 to the LED readout.

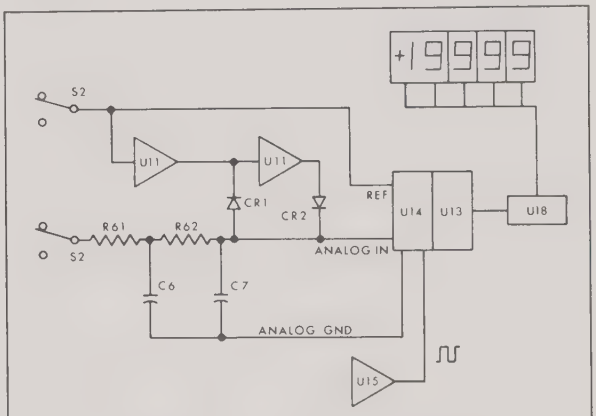


Figure 7: A/D converter and readout

7.0 CALIBRATION

Calibration of the Model 3800 to its specified levels of accuracy is beyond the capability of most user organizations. Special test configurations and test equipment capable of ±0.01% accuracies are required. It is recommended that the Model 3800 be returned to the factory for periodic recalibration at two-year intervals.

Any attempt by the user to replace defective components should be done with caution and with the realization that overall accuracies will likely be compromised. If such replacement is to be attempted, consult the Measurements Group Applications Engineering Department for guidance.

WARRANTY

Measurements Group, Inc., warrants all instruments it manufactures to be free from defect in materials and factory workmanship, and agrees to repair or replace any instrument that fails to perform as specified within one year after date of shipment. This warranty shall not apply to any instrument that has been:

i) repaired, worked on or altered by persons unauthorized by the Measurements Group in such a manner as to injure, in our sole judgment, the performance, stability, or reliability of the instrument;

ii) subjected to misuse, negligence, or accident;

or

iii) connected, installed, adjusted, or used otherwise than in accordance with the instructions furnished by us.

At no charge, we will repair, at our plant, or an authorized repair station, or at our option, replace any of our products found to be defective under this warranty.

This warranty is in lieu of any other warranties, expressed or implied, including any implied warranties of merchantability or fitness for a particular purpose. There are no warranties which extend beyond the description of the face hereof. Purchaser acknowledges that all goods purchased from Measurements Group are purchased as is, and buyer states that no salesman, agent, employee or other person has made any such representations or warranties or otherwise assumed for Measurements Group any liability in connection with the sale of any goods to the purchaser. Buyer hereby waives all rights buyer may have arising out of any breach of contract or breach of warranty on the part of Measurements Group, to any incidental or consequential damages, including but not limited to damages to property, damages for injury to the person, damages for loss of use, loss of time, loss of profits or income, or loss resulting from personal injury.

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Return transportation charges of repaired or replacement instruments under warranty will be prepaid by the Measurements Group, Inc.

The Measurements Group is solely a manufacturer and assumes no responsibility of any form for the accuracy or adequacy of any test results, data, or conclusions which may result from the use of its equipment.

The manner in which the equipment is employed and the use to which the data and test results may be put are completely in the hands of the purchaser. Measurements Group, Inc., shall in no way be liable for damages consequential or incidental to defects in any of its products.

This warranty constitutes the full understanding between the manufacturer and buyer, and no terms, conditions, understanding, or agreement purporting to modify or vary the terms hereof shall be binding unless hereafter made in writing and signed by an authorized official of Measurements Group, Inc.

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